just under it. On the second dip the tail went into its pursuer's mouth, and there was an end of the flyer. It always struck me that it seemed a strain on the fish to keep the wings extended.

May 15 ALFRED CARPENTER

THE UNIVERSAL MERIDIAN[1]

AFTER some preliminary historical matter Dr. Janssen proceeded:—The question as to which of all the meridians encircling the earth ought to serve as the starting line in the general numeration of the longitudes, is the question known as that of the *prime meridian*—a famous question oftentimes taken in hand, never definitively settled, and which the Congress of Washington was charged to decide. Such was at least its intention.

The ancients, who had just ideas in all matters, perfectly understood that a prime meridian ought to be placed at the origin of the lands to be measured. Marinus of Tyre, and after him Ptolemy, chose quite naturally, as the point of departure for their longitudes, the extremity of the world which was best known to them. What was this extremity? It was the islands which navigators encountered beyond the pillars of Hercules in an enchanting climate, where the inhabitants, freed from every toil, lived in peace and happiness on the abundant spontaneous fruits of a prodigal soil, the Fortunate Isles, as they were called, which people pleased themselves with assigning, as a final resting place (Elysian fields) to the souls of heroes!

Homer, Hesiod, Pindar, Plutarch, speak to us of these Fortunate Isles, which were then regarded as the extreme limit of the western dependencies of Africa. Afterwards they were the unknown solitudes of the ocean.

It is from these isles, then, that the great heir of the geography of the Greeks starts his numeration of longitudes. Here again, however, the ignorance of the ancients in the matter of measures did not allow the maintaining of so natural a point of departure. The indifferent knowledge of the position of the Fortunate Isles damaged the whole system, and people later on were compelled to revert to the continent where the measures were less uncertain.

Following Greek science came the middle ages, when the scientific idea disappeared, and was replaced by a religious or political idea. The first line of longitudes was taken anywhere. People took their meridians from capitals, or remarkable places; every one chose his own centre, and the confusion grew to be intolerable. It is noteworthy how it was France which gave the signal for the resuscitation of the scientific idea in this question, and that it is to the great Richelieu we owe it.

It is, however, a false idea of Richelieu's action to consider it as directed by a pure intention of scientific reform, and by the desire alone of serving the general interests. Richelieu is above all a political spirit, and political interests dominate his preoccupations. At the same time, however, he is a unifying and innovating genius, who feels the necessity of order and serves that necessity by general, great, and elevated measures, for such is the form of his spirit.

What, in fact, was the point of departure of a reform such as science disengaged from all personal interest would alone dictate at the present day? A jealous quarrel among maritime nations in reference to commerce!

At the commencement of the seventeenth century France made a trial of commerce in distant parts, particularly in the Indies and America.

The navigation and traffic of these countries were then in the hands of the Spanish and Portuguese, who, however little they agreed on the division of these rich spoils among each other, were nevertheless wonderfully united when there was a question of interdicting others from sharing in them. The French ships appearing in the seas either of the East or West Indies were, in point of fact, chased by the Spaniards and the Portuguese! Awaiting the time till he had rendered the French navy strong enough to dispute with these nations a property which on the whole was the right of all the world, Richelieu sought to draw around France a maritime zone of protection. He accordingly negotiated and obtained that on this side of the prime meridian fixed on this occasion and to the north of the tropic of Cancer every French ship, whencesoever it may have come and whatever its cargo, should be safe from the pursuit of foreign vessels. Beyond these limits the argument of the strongest was to have force. France was at peace with Spain and Portugal on this side, at war on the other. A curious state of affairs, recalling to some extent the word of Pascal: "Vérité en deçà, erreur au delà!"

And yet have we really the right at this day to look on an arrangement of this kind as such a strange one? Have we not now what the casuists of international law call the *état de représailles*—a state in virtue of which one may blockade the ports of a nation, burn its arsenals and destroy its armies, without being in declared war, and without ceasing diplomatic relations with it?

The object of the great Minister was evidently to secure a refuge for our marine till such time as it was able to contend with others—a goal for which he laboured with such admirable success that before his death our navy was constituted and the basis laid of that colonial greatness which came with Louis XIV. and Colbert.

Such, then, was the political motive at work. But in pursuing this question of colonial commerce the mind of Richelieu was for a moment turned to geography. He needed a pure line of demarcation, not liable to be disputed, and found it in the ancient meridian of the Canaries. He resumes the geographical idea of Marinus of Tyre and of Ptolemy. He places his meridian as far to the west as possible in the archipelago of the Canaries—in the island of Ferro, and the longitudes are to be counted east of it. All the other meridians of the continent are excluded.

Accordingly, and I insist on the fact, all the qualifications of a universal meridian, such as science might be able to establish at this day, were combined in Richelieu's meridian.

(1). It is universal and fit to be so, seeing it personifies no nation, but is, on the contrary, the determination of a purely geographical idea; namely, the position farthest to the west of the ancient world.

(2). The numeration of the longitudes is very natural. It brings the numerical augmentation of the longitude into harmony with that of the local time. It sets forth no negative longitude—a system which, in our opinion, is defective, when there is a question of universal numeration of longitudes.

(3). It places the first meridian in the sea, as geographers have always desired.

The appointment of Richelieu had but one fault: it was in advance of its time—not in respect of its utility and urgency, but of its means of realisation.

In order to establish a meridian at any point it is necessary to be able to connect this point exactly with all well-known points which are to be brought into relation to it. Now, by reason of various circumstances, chief amongst which was the state of war then prevailing, the longitude of this island of Ferro was not known till a century later, when P. Fouillée, astronomer and naturalist, proceeded to the Canaries by order of the King and the Academy, and there made observations on the occultations of the satellites of Jupiter, whence he determined the position of Orotara in Teneriffe, and consequently, by means of a triangulation, the position also of the island of Ferro.

[1] Lecture by Dr. Janssen at the Paris Geographical Society.

In the meantime a conventional position had been arranged for the island of Ferro. In fact, at the beginning of the seventeenth century our geographer Delisle is found placing the meridian of the island of Ferro on his maps 20° W. from Paris.

The grand geographical idea of Richelieu was, accordingly, not maintained in its integrity. Paris, in fact, gave the point of departure.

Delisle was a geographer of very great merit, and accomplished a real reform in the science by always seeking to establish astronomical determinations as the basis of geography. Delisle and d'Anville placed France in the seventeenth century in the front rank in geography. Be it added that, while France had thus an undisputed superiority in geography, she at the same time took the initiative in inventing hydrographic methods, and producing the most beautiful hydrographic works, as I had occasion to call to remembrance at the Congress.

In thus speaking of the labours of France shall we not be allowed to recall our present activity in the branches which engage us? I shall say but a word in passing. But in fine, are we not accomplishing great things even at the present day? The creation of the port of Rochelle, established on new and profound scientific principles; the geodetic junction of Spain and Africa; the great geodetic labours of France resumed; the publication of the astronomical and nautical ephemerides, the most complete and perfect in existence; the fair series of determinations of longitude of high precision, undertaken under the auspices of the Bureau of Longitudes; those sublime cosmogonical theories which are being elaborated at this very moment; finally, and without passing beyond the domain of geography, let us not forget the great enterprises of our president, who everywhere vindicates the genius of France, and whom age seems to spare in the interest of our glory—have we not in all that a sum of sterling substance, and is it not proper to call it to mind at a moment when every one is putting his claims forward?

These preliminary explanations made, we may now, with your permission, address ourselves to an analysis of the labours of the Washington Congress.

This Congress, assembled by the zeal of the United States Government, was formed by the diplomatic and scientific representatives of the different States invited. It was officially charged with the task of studying the question of a universal meridian and of cosmopolitan time, and of formulating propositions, which, it is true, were not to be binding on the Governments represented, but were yet to serve as a basis for further negotiations and definitive resolutions.

When the invitation of the American Government reached the Government of France, the latter applied to the Academy to name the delegates which should represent France scientifically at the Congress. This step was followed by the appointment of a Grand Commission comprising representatives of all the sciences and services interested, and in which the Academy of Sciences was largely represented.

This Commission, presided over by the Dean of our Astronomical Section, held numerous meetings, at which they discussed with the greatest care and with high authority the questions composing the programme of the Washington Congress. The resolutions which this Commission adopted, formulated in a remarkable report of M. Gaspari and fully accepted by the Government, formed the basis of the instructions given to the French delegates.

The Congress opened on October 1 in the Diplomatic Hall of the Department of State.

On the formal demand of the French delegation the Congress allowed that the motions and speeches delivered in the English language should be translated into French, and that the *procès-verbaux* should be drawn up in the two languages. To secure the accuracy of the French version M. Janssen accepted the duties of secretary.

The Congress invited certain learned men present at Washington to assist at the sittings, and to take part in the discussions. Among them may be named Messrs. Newcomb, Asaph Hall, Sir William Thomson, and Prof. Hilgard.

On examining the composition of the assembly it will be seen how largely England and America were represented, and yet, to add to the force which such a numerous and eminent representation was calculated to give them in the discussion, there was joined to it, under the form of invitation, the support of the most eminent men of learning of America or England present at Washington.

Finally, without at all wishing to call in question the independence of any one present at the Congress, it is yet difficult not to be struck by the fact of invitations being addressed to all the small States politically allied with the United States.

Such was the arena on which France was called to defend her interests.

Luckily, however, we had no personal interest to contend for. The France of the nineteenth century does not, any more than the France of the eighteenth and seventeenth centuries, deem herself entitled to consider national interest in questions of a scientific and universal character.

In conformity, therefore, with the spirit which ruled the institution of the metrical system the French representation at the Washington Congress solely maintained the principle of a meridian such as science would designate and such as would be most advantageous for the general interest.

At the opening of the sittings a member of the American delegation, expressing, no doubt, the sentiment of his colleagues, at once proposed the meridian of Greenwich as the international meridian. If this proposition had been adopted the main question which called the Congress together would have been decided, and that, so to say, without discussion, and without the questions of principle and general interest, which we wished to defend, being so much as entered on.

The delegate of France raised his voice against this summary and inadmissible method of procedure. He pointed out that, before proceeding to choose any meridian in particular, it was necessary to come to a decision on the question as to whether a universal meridian should be fixed upon or not, and, if this question were settled in the affirmative, according to what principles they should choose this meridian.

The legitimacy of this demand was evident. It was accepted, and the proposition of the American delegate was temporarily withdrawn.

The question of fixing a single meridian of departure for all nations having been submitted to the Congress, it was unanimously agreed to choose such a meridian.

It next remained to be decided according to what principle this meridian should be chosen—whether, namely, the choice should be made among the observatories already existing, or whether the choice should be made with a view exclusively to geographical conditions, and to the service which the meridian was destined to render.

On this question the French scientific delegate begged permission to speak, and delivered the following discourse:—

"If after so many fruitless attempts recorded by history to arrange a single universal system of longitudes this question is now again resumed, then in our opinion it has no chance of definitive success unless it is established on a purely geographical basis to the rigorous exclusion of all national rivalries.

"We do not, therefore, come here to support a candidature, we put ourselves completely outside the arena of

debate, and are consequently infinitely freer to express our opinion and discuss the question from the one point of view of the interests of the projected reform.

"The history of geography shows us very numerous attempts at the unification of longitudes, and on searching into the causes of the failure of those attempts, many of them very happily conceived, one is struck by the fact that they seem reducible to two main causes, one of a scientific, the other of a moral nature. The cause of a scientific nature lies in the inability of the ancients to determine exactly the relative positions of points taken on the globe, particularly in the case of an island removed from a continent, where the distance between the two was not determinable by itinerary measures.

"It was thus, for example, that the first meridian of Marinus of Tyre and of Ptolemy, placed in the so-called Fortunate Islands, could not continue to be used, notwithstanding the advantage belonging to the choice of a position in the extreme west of the then known world, on account of the uncertainty attaching to this point of departure.

"This very regrettable reverse served to give a wrong direction to the question. People were obliged to revert to the continent. Instead of regarding a common origin of longitudes indicated by nature, people took their first meridian from a capital, from remarkable places, from observations. The second cause to which I referred, the cause of a moral kind—namely, national jealousy—led to the multiplication of geographical origins, whereas the nature of things would have demanded their reduction to one single origin.

"In the seventeenth century Cardinal de Richelieu, seeing this confusion, wanted to resume the idea of Marinus, and assembled at Paris learned men of France and foreign countries. The famous meridian of the island of Ferro was the result of their conferences. Here is a lesson which we ought not to lose sight of: the meridian of the island of Ferro, which had at first the purely geographical and neutral character alone able to render it, and maintain it as, a first international meridian, was displaced from its primary position by the geographer Guillaume Delisle, who, to simplify the figures, placed it in round numbers 20° west of Paris. This unhappy simplification completely changed the principle of impersonality. It was no longer an independent meridian, but the meridian of Paris disguised. Nor were the consequences slow in making themselves felt. The meridian of the island of Ferro, from that time regarded as a purely French meridian, wounded national susceptibilities, and thus lost the future which was certainly in store for it had it remained true to its first intention.

"This was a real misfortune for geography. Our maps in their process of improvement ought to have maintained the unity of departure, instead of confusing it ever more and more.

"If from the time when astronomical methods were sufficiently advanced to allow the fixing of relative positions with the degree of precision required for general geography (a state obtaining from the end of the seventeenth century), the idea of Marinus of Tyre, so just and so geographical, had been resumed, the reform would have been effected two centuries sooner, and we should now have been in the full enjoyment of it. But people fell into the error of losing sight of the very principles of the question, an error to which the foundation and multiplication of observatories at that time greatly contributed. Furnishing relative positions, as they of course did, with great precision, each of these establishments was chosen by the nation possessing it to give it a point of departure for longitudes, so that the intervention of astronomy in these questions of a geographical nature—an intervention which, properly understood, should have been so advantageous—served only to remove us further from the object to be attained.

"The study of these questions leads us to establish a very necessary distinction between the meridians of a geographical or hydrographical nature, and the meridians of observatories.

"The meridians of observatories must be regarded as essentially national. Their office is to enable observatories to depend on each other for the unification of their observations. They also serve as a basis for geodetic and topographical labours executed in connection with them. Their functions, however, being of an entirely special character, ought in general to be limited to the country possessing them.

"The first meridians in geography, on the other hand, do not require to be fixed with a precision quite so delicate as that exacted by astronomy; but in return their domain ought to be comprehensive, and while it is serviceable to multiply observatories, it is necessary to reduce to the utmost the origins of longitude in geography.

"It may further be said that if the site of an observatory ought to be chosen under considerations of an astronomical description, a meridian of departure in geography ought to be fixed on grounds of a geographical description.

"Have these two so different functions always been well comprehended, and a distinction of such vital moment properly observed? By no manner of means.

"Seeing the observatories, by reason of the labours of high precision executed by them, furnish admirable data, each nation in a position to do so has assigned to its principal observatory not only the geodetic or topographical works undertaken at home—a task very proper to it; but likewise the general works of geography or hydrography executed abroad—a confusion of functions comprising in it the germs of all the difficulties under which we now labour.

"In proportion, therefore, as cartographic labours accumulated, the necessity of establishing unity in all that relates especially to general geography became more and more felt. This explains how the question of a single meridian of departure has been so often raised in recent times.

"Among the assemblies occupied with this question that principally deserving our attention is the one held at Rome last year. For many even of our colleagues the conclusions adopted by the Congress of Rome settle the matter. Those conclusions must, therefore, very particularly engage our attention.

"On reading the reports of the sittings of that assembly I was struck by the fact that in a meeting embracing so many men eminent for their learning and speculations, it was the *Utilitarian* side of the question which was especially considered, and which finally dictated the sense of the resolution taken.

"Thus, instead of laying down the great principle that the meridian which should be offered to the world as a point of departure for all the longitudes of the earth ought, above everything else, to have an essentially geographical and impersonal character, the question was simply asked, which among the meridians of observatories was the one possessing—permit me the expression—the largest following (*la clientèle la plus nombreuse*).

"In a question of a geographical, much more than of a hydrographical, interest, as almost all mariners confess (seeing that, in fact, there exist but two prime hydrographical meridians, Greenwich and Paris), a primary meridian is taken, the dominating character of which is marine. And this meridian, instead of being chosen according to the configuration of the continents, is claimed for an observatory. That is to say, the prime meridian is chosen for a mere chance spot on the globe, and one which, moreover, is very inconvenient, for the function the meridian is intended to perform. Instead, finally, of profiting by the lessons of the past, an element of national rivalry is

introduced into a question which ought to unite the votes of all interested.

"Well, I say that considerations of economy and of use and wont ought not to blind us to the principles which should govern this question, and which can alone render its settlement universally acceptable and permanent.

"But further, this argument of economy, and use, and wont, which is advanced as a reason of determinative force, has validity, it is true, for the majority for whom it is brought forward, but for them alone, and leaves for us exclusively the burden of change in habits, publications, and maps.

"Seeing the report holds us of so light account in the balance, allow me briefly to recall the past and the present of our hydrography, and for this purpose I cannot do better than cite a few passages from a work communicated to me, and emanating from one of our foremost hydrographers. 'France,' says he, 'created more than two centuries ago the oldest nautical ephemerides in existence. She was the first to conceive and execute the great geodetic operations having for their object the construction of maps civil and military, the measure of meridional arcs in Europe, America, and Africa. All these works were and are regulated by the meridian of Paris. Almost all the astronomical tables which the astronomers and mariners of the entire world make use of at this day are French, and calculated in reference to the meridian of Paris. As regards oceanography, more particularly marine surveying, the precise methods employed at the present day by all the nations are of French origin, and our maps, all based on the meridian of Paris, bear names such as those of Bourgainville, La Pérouse, Fleurieu, Borda, d'Entrecasteaux, Beautemps Beaupré, Duperrey, Dumont d'Urville, Daussy—to mention but a small number of those who are no more.

"Our existing hydrographical collections count more than 4000 charts. Deducting from this number those which the progress of exploration has rendered no longer available, there remain about 2600 charts in use.

"Of this number more than a half represent original French surveys which foreign nations have in great part reproduced. Of the remainder the general maps are the result of the labours of discussion carried out at the marine depôt where all documents, French as much as foreign, were utilised, and relatively few of them are the expressions pure and simple of foreign labours. Our surveys are not limited to the coasts of France and its colonies. There is hardly a region on the globe for which we do not possess original labours: Newfoundland, the coasts of Guiana, of Brazil and La Plata, Madagascar, numerous points of Japan and China, 187 original charts relative to the Pacific Ocean. We must not omit mentioning the fine work of our hydrographical engineers on the West coast of Italy, which was honoured by the International Jury with the grand medal of honour at the universal exhibition of 1867. The exclusive use by mariners of the meridian of Paris is grounded on considerations of a past of 200 years such as we have briefly recalled.

"The adoption of another prime meridian would involve a change in the graduation of the 2600 charts of our hydrography, would involve a similar change in our maps for nautical instruction numbering over 600, and would of necessity entail a corresponding change in the *connaissance des temps*.

"These are considerations deserving to be pondered. Well, if under these conditions the projected reform, instead of being inspired by the high principles which should govern this subject, is to take for its basis simply a regard for the use and wont of the largest number and their exemption from all sacrifice, reserving for us exclusively the burden of change and the abandonment of a dear and glorious past, are we not, then, justified in saying that a proposal formulated in this sense would not be acceptable?

"When at the end of the last century France established the metre, did she proceed in this way? Did she, as a measure of economy, and not to change anything in her habits, propose her foot-rule to the world? You know the facts. The truth is, we turned everything at home topsy-turvy—habits and material. And the measure chosen related, as it is, only to the dimensions of our globe, is so well disengaged from every French tie that in future ages the traveller who will trample on the ruins of our cities will be able to ask himself by what people was invented the metrical measure which his feet may chance to light on.

"Permit me to say that it is in this way a reform is established and rendered acceptable. It is by setting oneself the example of self-sacrifice and by completely effacing oneself in his work that resistance is disarmed and that a sincere love of progress is attested.

"I hasten to say that I am persuaded that the proposal voted at Rome was neither made nor suggested by England, but I doubt whether, if accepted, it will render a true service to the English nation. An immense majority of the sailors of the globe navigate with English charts, it is true, but it is a homage of fact rendered to the great maritime activity of this nation. The day, however, when this supremacy, freely accorded, is changed into a supremacy official and imposed, it will undergo the vicissitudes of every human power, and this institution, which by its nature is of a purely scientific order, and to which we desire to assure a long and peaceable future, will become an object of keen and jealous rivalry among the nations.

"All this shows how much wiser it would be to take for the origin of terrestrial longitudes a point determined by purely geographical considerations. On our globe nature has so distinctly separated the continent on which the great American nation are now developing themselves that from a geographical point of view there are but two possible solutions, both very natural.

"The first solution would consist in returning to the solution of the ancients with a little modification, by placing our first meridian towards the Azores; the second in relegating it to the immense straits separating America from Asia, towards the confines of the north, where the New World reaches out a hand to the Old.

"These two solutions may be discussed, as they have often and again quite recently been by one of our ablest geologists, M. de Chancourtois.

"Each of these meridians unites in it the fundamental conditions required by geography, and on which people have always been agreed, when national meridians were eliminated from the debates. As to the determination of the point adopted, the astronomical methods which are now so perfect would furnish it with as a great a degree of exactness as geography would require.

"But what need of a special and costly determination of longitude for a point which may be placed arbitrarily provided it is comprised within certain limits, such as to satisfy the condition, for example, of passing by a strait or traversing an island? It is enough to mark out approximately the point adopted. The position thus obtained will be referred to each of the great observatories, which will be related to one another and chosen for this purpose, and this list of relative positions will constitute the definition of the first meridian. As to a material sign on the globe, should such be wanted, a point by no means necessary, it will have to be placed in conformity with this definition, its place would have to be shifted till such conformity was obtained.

(*To be continued.*)